

## CLAIMS

What is claimed is:

1. A method for monitoring material properties comprising:  
mounting an electromagnetic sensor on a test material surface; and  
5 periodically measuring at least one electrical property of the material  
under the sensor footprint.
2. A method as claimed in Claim 1 where the sensor is an eddy-current sensor.
3. A method as claimed in Claim 1 where the sensor is a conformable spatially  
periodic field eddy-current sensor.
- 10 4. A method as claimed in Claim 3 where the sensor has a periodic primary  
winding to excite a periodic magnetic field and at least one sensing element to  
detect variations in the magnetic field related to electrical properties of the  
material under test.
5. A method as claimed in Claim 4 where multiple sensing elements are used to  
15 measure absolute electrical conductivity at each sensing element location with at  
least one primary current excitation frequency.
6. A method as claimed in Claim 5 where at least one sensing element is located in  
a region expected to see less damage than at other elements.
7. A method as claimed in Claim 6 where the sensing element at the location of  
20 less damage is used as a reference for measurements at other elements.

8. A method as claimed in Claim 1 further comprising intentionally varying the temperature of the material under test to verify the proper performance of the sensor.
9. A method as claimed in Claim 1 further comprising intentionally varying the temperature of the material under test, recording the temperature variations with a temperature measurement sensor, and recording the sensor data at a plurality of temperature levels.
10. A method as claimed in Claim 9 further comprising calibrating the sensor using the sensor data at different temperatures.
- 10 11. A method as claimed in Claim 9 further comprising assessing the test material condition using sensor data at multiple temperatures.
12. A method as claimed in Claim 1 further comprising measuring the electrical property at specified times.
13. A method as claimed in Claim 12 further comprising using a change in the electrical property above the noise level to indicate a significant change in the test material condition.
14. A method as claimed in Claim 1 further comprising mounting the sensor with a gap between the sensor and the test material to permit the environment under the sensor to substantially match the environment if the sensor was not present.
- 20 15. A method as claimed in Claim 1 further comprising perforations in the sensor to allow corrosion to occur at the test material surface.

16. A method as claimed in Claim 1 further comprising providing guides to permit scanning eddy-current sensors to inspect with the permanently mounted eddy-current sensor remaining in place.
17. A method as claimed in Claim 1 further comprising a mechanism to permit  
5 relative motion of the sensor windings relative to the test material using a remote actuation.
18. A method as claimed in Claim 3 further comprising shaping the test material to create a stress distribution so that fatigue damage initiates under the sensor.
19. A method as claimed in Claim 18 where the test material is formed into a  
10 dogbone shape and the center section is thinned to localize fatigue damage.
20. A method as claimed in Claim 19 where the test material further comprises reinforcement ribs on the edges.
21. A method as claimed in Claim 20 where the test material further comprises radius cutouts on both sides of the thinned section.
- 15 22. A method as claimed in Claim 18 where the test material further comprises radius cutouts on both sides of the thinned section.
23. A method as claimed in Claim 1 where the sensor is conformable.
24. A method as claimed in Claim 1 where the sensor is a dielectrometer.
25. A method as claimed in Claim 1 where a second sensor is incorporated with the  
20 electromagnetic sensor.

26. A method as claimed in Claim 25 where the second sensor is a strain gauge.
27. A method as claimed in Claim 25 where the second sensor is a temperature gauge.
28. A method as claimed in Claim 1 where the sensor comprises a drive conductor  
5 to carry an applied electric current and at least one sensing element to measure the electrical properties of the material under test.
29. A method as claimed in Claim 28 where the sensing elements are absolute inductive coils.
30. A method as claimed in Claim 28 where the sensing elements are  
10 magnetoresistive elements.
31. A method as claimed in Claim 28 where the sensing elements are SQUIDS.
32. A method as claimed in Claim 28 where the sensing elements are differential inductive coils.
33. A method as claimed in Claim 1 where measurement grids are used to convert  
15 the sensor response to one or more properties of interest.